9. DEVELOPING AN EXIT STRATEGY

Introduction

An exit strategy is the plan that determines how and when an activity will be terminated. Experience has shown that without an exit strategy, it is difficult to reach consensus on stopping remediation or monitoring efforts. Uncertainty as to whether unacceptable risk has been mitigated and reluctance to take responsibility for declaring a situation safe, lead to default positions that continually extend operations until some undefined event makes it clear that termination is safe. Unfortunately, without a clear definition as to what that undefined event would look like (i.e., an exit strategy) there is never consensus that it has been observed. Therefore, just as it is prudent to note the fire exits when entering a building, it is prudent to understand what is required to stop an activity before it is begun.

This chapter discusses the concept of end state and its central role in the development of an exit strategy. It notes the different nature of end states that arise from application of different types of responses and introduces the notion of stewardship and long-term care for those responses that result in leaving residues in place for the foreseeable future. Phased exit strategies are discussed as are documentation and knowledge management issues associated with closeout.

Exit Strategies and End States

Exit strategies are needed for any long-term obligations including monitoring, operation, maintenance, or other activities not required in perpetuity. (By definition, there is no exit for requirements in perpetuity.) In general, exit strategies will apply to any remedy in which residues above action levels are left in place under circumstances that reasonably can be expected to ultimately result in concentration reductions below those levels. Hence, an exit strategy may be appropriate for a containment remedy involving a cap over degradable waste, but may not be for inorganic contaminants. Similarly, exit strategies are appropriate for pump and treat and natural attenuation responses regardless of the projected timeframes in which RAOs are expected to be met.

Exit strategies define the conditions or state to be achieved; the actions necessary to reach that condition or state; and the amount, type, and origin of data necessary to demonstrate that the state or condition has been reached. As such, exit strategies must be tailored to the response action and the end state for the response application as specified in the decision document. In order to tailor exit strategies and better understand when they are required, it is first necessary to define some related terms.

In general, completion is defined as the end of installation (i.e., construction complete) and start-up activities (system operational and functional). Construction completion may equate to response completion for some types of response (e.g., excavation, in-situ treatment). For other responses (e.g., pump and treat, monitored natural attenuation), there may be significant activities after construction completion to ensure the remedy stays on the path to response complete. Continuing activities may include operation of pump and treat facilities, monitoring under an MNA response, or similar long-term activities conducted to cause or verify that the site contaminant inventory is continuing to approach the desired long-term monitoring state.

Response complete is defined as the point at which the desired end state has been reached. Response complete can occur with an inventory of contaminant in place if that inventory is within the desired end state (e.g., under a well-maintained cap).

The end state may be defined as target characteristics or conditions for a site that the response has been designed to attain. It describes the physical condition of the site once remediation activities are complete. It can include both clean closure and closure with containment of residuals.

Site Closeout means that the responsible party has completed active management and monitoring at an environmental restoration site and no additional environmental restoration funds are expected to be expended at the site, unless the need for additional remedial action is demonstrated as a result of other unplanned activities.

Exit Strategy Content

An exit strategy should define the data necessary and sufficient to demonstrate that the desired end state or condition has been reached. For some activities such as long-term monitoring, a phased exit plan may be appropriate that includes criteria for ramp downs associated with levels of greater confidence gained through the monitoring data.

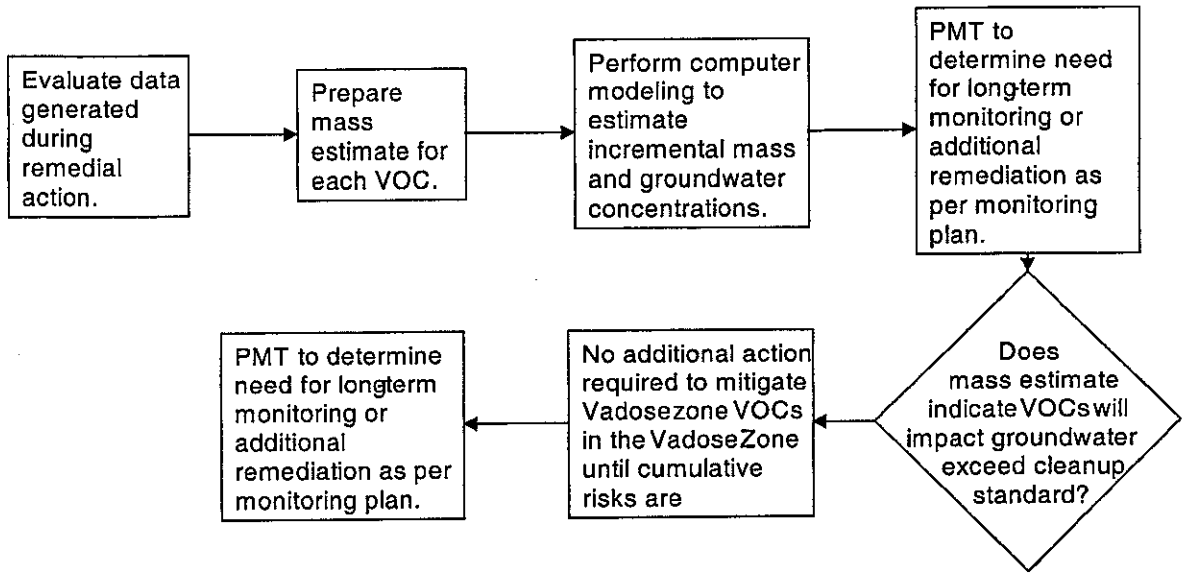
An exit strategy should specify several parameters:

- The type of data required;
- Sample locations;
- Sample frequency;
- Target parameter thresholds characteristic of the desired long-term monitoring state;

- Duration required to demonstrate sustainability; and
- Statistical algorithms to be applied to data (e.g., confidence limit, type of mean, etc.).

Figure 9-1 is a simplified logic diagram illustrating a rudimentary exit strategy for an SVE remedy. Ideally, it would identify the data to be used as input to the model (which wells, etc.) and criteria for stopping the monitoring being conducted to look for evidence of rebound contamination.

Figure 9-1: Example of an Exit Strategy



Monitoring Plan Considerations

Exit strategies for monitoring activities are developed around a set of decision criteria. At a minimum, criteria should be developed that address three potential modes of monitoring reduction, as illustrated by the following examples:

- Eliminate unnecessary analytes, including:
  - Analytes not found in initial samples and for which there is no evidence of a release;
  - Analytes not identified above detection limits in three successive samples; and

- Analytes detected at less than half the action level for at least three successive samples and displaying a static or downward trend.

- Eliminate redundant locations (wells), including:

  - Wells in the interior of plumes whose boundaries are defined by other wells (these wells may be needed to support performance monitoring for response such as monitored natural attenuation);

  - Wells outside plumes and not deemed to be in the pathway of on-coming plumes and not required to establish background;

  - Wells duplicated by proximate wells on the same isopleth; and

  - Wells for which analytical data will have no clear use in future decision making such as consideration of when to implement a contingency.

- Reduce sampling frequency:

  - Initial quarterly sampling is needed to establish seasonal variations. Annual monitoring helps identify variations resulting from changes in precipitation (wet versus dry years). Beyond those distinctions, sampling frequency should be selected on the basis of the slope of the observed trend lines, the degree to which empirical data match predictions, and the relative velocity of groundwater. The more predictable the data are, the less need there is for frequent confirmation.

  - Monitoring is only required when there is uncertainty as to the fate and transport of contaminants and the effectiveness of remedies that are implemented. As the uncertainty is reduced, or as its consequences become less significant, the need for further monitoring is diminished. Similarly, slow moving groundwater requires less frequent monitoring because trends are slower to develop and there is more time to respond to them.

Performance monitoring is conducted to determine if performance is meeting expectations. This may include looking at contaminant inventory as well as other indicators, such as geochemical parameters, during monitored natural attenuation. To the extent that performance data verify predicted trends for performance meeting expectations, they can be used to justify reducing monitoring activities in the future. In some situations, monitoring may trigger a re-evaluation of what needs to be done.

Detection monitoring is performed at sentinel wells to ensure that contaminants are not approaching exposure points at concentrations that pose unacceptable risk. Ambient monitoring involves the measurement of background conditions on a regular basis to provide a benchmark for evaluating detection and performance monitoring results. For post-closure monitoring, contingencies may not be well-developed due to assumed low probability of need, but a general response should be identified

In many cases it is technically or economically infeasible to fully remediate a site because of the degree of contamination and the type of contaminants present. At these sites, additional monitoring, maintenance, and contingency plans will be required to ensure that human health and the environment remain protected after RAOs have been met. The PMT will need to describe how to ensure that the response remains protective after it has been determined that the long-term monitoring state has been reached. Activities may be required to maintain an adequate level of protection to human health and the environment from the hazards posed by chemical materials, waste, and residual contamination remaining after cleanup is completed. Activities required may include safeguarding Chemical and Biological Warfare (CBW) materials, monitoring the migration of contamination and the effectiveness of response, inspecting disposal cells, enforcing physical access restrictions, implementing permits and other legal or institutional controls, maintaining relevant information, and generally providing responsible long-term care of a site.

No monitoring program should be implemented without some form of decision criteria or a contingency plan to indicate how unsatisfactory results will be defined (i.e., what constitutes evidence of failure?) and addressed (i.e., what response /contingency will be implemented when unsatisfactory performance is confirmed?) and how success will be demonstrated and what that means with respect to future activities. Because knowledge of the site may increase with collection and review of monitoring data and because technology is continually evolving, monitoring and contingency plans should be subject to review and modification as an integral part of the mandatory 5-year review of remedies.

Documentation

A construction complete report is written after completion of construction activities. The report is intended to document as-builts, define any RAO requirements, identify any long-term care requirements and, when the desired end state is reached, document target achievement. If the PMT adhered to the Principles throughout the project, this document will mostly be written. It is largely an aggregation of existing by-products of implementation.

Under RCRA, a written post-closure plan is required that will become part of the RCRA permit issued to the owner or operator. This report must detail the

activities to be carried out after the response is complete at each hazardous waste management unit. To amend this plan, the owner or operator must submit a written notification of, or request for, permit modification (40 CFR 264.118).

Under CERCLA, in the case of long-term remedial action sites (LTRA), an interim closeout report is developed. LTRAs are sites where achieving the RAOs require continuous operation of the response over several years. When the cleanup levels are achieved, a final closeout report is developed and submitted for EPA review and concurrence.

Figure 9-2 illustrates the essential elements of a closure report. As in the case of the construction complete report, most of the required information is already available (i.e., generated during implementation); thus, documentation should require little new effort at this time.

Figure 9-2: Elements and Source of Completion/Closure Reports

Completion/Closure Report Element	Source
Problem statement	Scoping and decision document decision rules
Description of selected response	Decision document
Details of implementation	"As-builts," notice of modifications
Contingencies executed	Memoranda filed to document need for and use of contingencies
Performance status	Results of performance measurements
Verification of completion/ closure	Evaluation of performance measurement results in the context of the definitions of construction complete
Design of O&M (completion) long-term care (closure)	"As-builts," decision document specifications, operations manual

Depending on the nature of the remedy selected, construction complete and closure may be concurrent (e.g., clean closure or containment) or may be separated by a period of operation and maintenance. If the end state leaves contaminants in place at concentrations above risk thresholds (e.g., capping) closure is followed by long-term maintenance and stewardship.

The role of the PMT changes once response is complete. There is a need to determine lines of authority/responsibility for future actions, including when to invoke contingencies. The PMT is responsible for:

- Sharing appropriate response information and data with long-term care authorities [assures knowledge management (archiving) for future stakeholders];
- Conducting five-year reviews; and
- Delegating authority for future actions as appropriate.

Summary

Exit strategies are devised to define in advance the conditions and confirmatory data needed to receive approval to terminate remedial action activities. Any activity without a defined end point, other than those assumed to continue in perpetuity, requires an exit strategy. Strategies should include a definition of the data required to confirm termination is appropriate and the decision criteria to which those data will be subjected.

Long-term monitoring activities may benefit from adoption of a phased exit strategy that ramps down requirements and cost commensurate with the degree of confidence gained in the remedy's performance. Performance monitoring relates to tracking actual performance against predicted performance. Detection monitoring provides a safety net to protect receptors should contaminants escape capture. Whenever monitoring is required, it should be accompanied by a contingency plan for actions necessary if monitoring results deviate significantly from predictions.

Construction completion and closeout are documented in reports assembled largely from existing information. These documents should be designed to facilitate knowledge transfer to future stewards of LTRA.